

Applicant: Sebastian KANNE et al.
Docket No. R.305558
Preliminary Amdt.

AMENDMENTS TO THE SPECIFICATION:

Page 1, please add the following new paragraphs before paragraph [0001]:

[0000.2] CROSS-REFERENCE TO RELATED APPLICATIONS

[0000.4] This application is a 35 USC 371 application of PCT/DE 2004/000738
filed on April 8, 2004.

[0000.6] BACKGROUND OF THE INVENTION

Please replace paragraph [0001] with the following amended paragraph:

[0001] ~~Prior Art~~ **Field of the Invention**

Please replace paragraph [0002] with the following amended paragraph:

[0002] The invention relates to an **improved fuel** injector ~~as generically defined by the
preamble to claim 1~~ **for injecting fuel into an internal combustion engine.**

Please add the following new paragraph after paragraph [0002]:

[0002.5] Description of the Prior Art

Please replace paragraph [0003] with the following amended paragraph:

[0003] An injector of ~~this~~ **the** generic type **with which this invention is concerned** has been disclosed by German Patent DE 195 19 191 C2. In the subject of that patent, the piezoelectric actuator and booster piston are seated on the upper end of the injector body, and the force transmission to the nozzle needle, located on the lower end of the injector body, is effected via a long tappet. The tappet is in hydraulic communication with the fuel inflow. A pressure conduit machined into the injector body leads to the nozzle outlet. An annular chamber surrounding the tappet in its lower region is also provided, at which a fuel return conduit originates. The fuel return conduit communicates hydraulically with an inner chamber,

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extending above the tappet, of the booster piston. A control chamber embodied below the booster piston is supplied from the fuel inflow via a leakage gap surrounding the tappet in the injector body.

Please replace paragraph [0004] with the following amended paragraph:

[0004] The known injector is complicated in its construction, ~~and~~ is composed of a comparatively ~~many~~ **large number of** components, and does not meet the stringent demands made of modern fuel injection systems, in particular common rail systems for diesel engines.

Page 2, please replace paragraph [0005] with the following amended paragraph:

[0005] ~~Advantages of the Invention~~

SUMMARY AND ADVANTAGES OF THE INVENTION

Please replace paragraph [0006] with the following amended paragraph:

[0006] With the prior art described above as the point of departure, it is the object of the present invention to ~~create~~ **provide** an injector ~~that is (also)~~ suitable for common rail systems, that is comparatively simple in construction, that makes do with a minimum number of individual parts, and that operates efficiently.

Please delete paragraphs [0007] and [0008].

Please replace paragraph [0009] with the following amended paragraph:

[0009] **Advantageous features of the fundamental concept of the invention are disclosed.** A substantial advantage of the invention resides in the direct control of the nozzle needle by the piezoelectric actuator. The speed of the nozzle needle motion can be adjusted via the course of voltage of the piezoelectric actuator. For metering especially small

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preinjection quantities, a partial stroke may also be predetermined. A further advantage, particularly over the known injector of DE 195 19 191 C2, is that the injector of the invention ~~has is also considered to be that it~~ makes do without a fuel return.

Page 3, please replace paragraph [0010] with the following amended paragraph:

[0010] Drawing **BRIEF DESCRIPTION OF THE DRAWINGS**

Please replace paragraph [0011] with the following amended paragraph:

[0011] The invention is ~~illustrated in terms of an exemplary embodiment in the drawing and described in detail below. Shown (in each case schematically) are:~~ **more fully described herein below, with reference to the drawings, in which:**

Please replace paragraph [0012] with the following amended paragraph:

[0012] Fig. 1[[,]] ~~one embodiment of~~ **is a sectional view schematically showing** a direct-controlled common rail injector with a piezoelectric actuator[[,]] ~~in vertical longitudinal section; and~~

Please replace paragraph [0013] with the following amended paragraph:

[0013] Fig. 2[[,]] [[a]] **is an enlarged view of the** lower position of the injector of Fig. 1[[,]] ~~in an enlarged view compared to Fig. 1.~~

Please replace paragraph [0014] with the following amended paragraph:

[0014] Description of the Exemplary Embodiment

DESCRIPTION OF THE PREFERRED EMBODIMENT

Please replace paragraph [0015] with the following amended paragraph:

[0015] Reference numeral 10 designates a cylindrical injector body, with a continuous cylindrical recess 11 extending over the majority of the length of the injector body. On its upper end, the recess 11 has first a conically narrowing portion 12, which changes over to a **right-angled conduit** portion 13, 14 ~~that is bent at a right angle~~ and finally discharges to the outside. Located in the cylindrical portion 15 of the recess 11 is a likewise cylindrical piezoelectric actuator 16 of comparatively great length, whose diameter is less than the inside diameter of the recess portion 15. This creates an annular chamber 17 between the outer wall of the piezoelectric actuator 16 and the inner wall of the injector body 10. For the requisite centering of the piezoelectric actuator 16 inside the injector body 10, the conical portion 12 of the axial recess 11 is used, for one thing. For another, as needed, fluid-passable shims (not shown) may be provided in the annular chamber 17, at defined axial spacings from one another.

Page 5, please replace paragraph [0022] with the following amended paragraph:

[0022] A further special feature is that the inner chamber 25 of the nozzle body 20 has a stepped increased diameter 41 at the top, in which the booster piston 32 is guided in such a way that a control chamber 42, embodied in the widened inner chamber portion 41 below the booster piston 32, is in hydraulic communication, via a leakage gap 43 (see in particular Fig. 2), with the annular chamber 17 of the injector body 10. A portion 44 of comparatively small diameter of the nozzle body inner chamber 25 serves to guide the nozzle needle 21 inside the nozzle body 20. This guide fit 44 is also conceived such that a leakage gap 45 (see in

particular Fig. 2) is created. The control chamber 42 thus communicates hydraulically via the second leakage gap 45 with the cylindrical chamber 37, which in turn is subjected to high pressure, ~~[[-]]~~ via the recesses 38, **39 and chamber** ~~through~~ 40 ~~[[-]]~~ from the annular chamber 17 of the injector body 10.

Page 6, please replace paragraph [0025] with the following amended paragraph:

[0025] A further special feature is that a ~~[[()]]~~second~~[[()]]~~ helical compression spring 48 is located in the inner chamber 31 of the booster piston 32 and exerts a force on the nozzle needle 21 that is oriented in the closing direction **indicated by the** ~~[[()]]~~arrow 49~~[[()]]~~. Thus by means of the ~~[[()]]~~second~~[[()]]~~ compression spring 48, the nozzle needle 21 is kept closed during the intervals between injection events and when the ~~vehicle~~ **engine** is stopped. In Figs. 1 and 2, the opening position of the nozzle needle 21 is shown. It is in this position that the injection event takes place, in which from the cylindrical pressure chamber 37, fuel passes through the outlet bores 26, 27 to reach the cylindrical combustion chamber (not shown) of the engine.

Page 8, please replace paragraph [0031] with the following amended paragraph:

[0031] If the pressure in the control chamber 42 decreases to the rail pressure, then the nozzle needle 21 executes a motion downward (in the direction of the arrow 49), until with the jacket face of its conical tip 29 it closes the outlet bores 26, 27. For closing the nozzle needle 21, the electrical triggering of the piezoelectric actuator 16 is interrupted. The piezoelectric actuator 16 thereupon ~~compresses~~ **contracts**, and the pressure in the control

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chamber 42 drops below the rail pressure. As a result, the nozzle needle 21 experiences the requisite closing forces, and it closes.

Page 9, please add the following new paragraph after paragraph [0032]:

[0033] The foregoing relates to preferred exemplary embodiments of the invention, it being understood that other variants and embodiments thereof are possible within the spirit and scope of the invention, the latter being defined by the appended claims.